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Mr. Hindorff,

Welcome to Cinepak. Enclosed you will find all of the related files and documents to the Cinepak technology. There are two disks: One containing the SEGACodec, MovieToSega application, and the Player binaries; The other containing a sample Cinepak application for the Snasm CD. The enclosed User's Guide explains how to get started and use the Cinepak technology. Provided with the manual is Technical Bulletin #1, a recent update to the User's Guide. The CD ROM included shows some sample movies which have been compressed with SEGA Cinepak.

The current version is 1.2. New to MAINPLAY.BIN and SUBPLAY.BIN is a way to verify the version of this code. Embedded in the source is the ASCII string 'CINEPAK VER 1.2' which may be viewed with a binary editor.

If you should have any questions or comments about Cinepak please feel free to contact me at (415) 802-3187.

Thank You,

Kevin Wagner
Sega of America
Developer Technical Support

Cinepak for SEGA-CD™
User's Guide

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Trademark Acknowledgments

In an effort to keep this document brief and to save our natural resources, we do not list a specific trademark reference for every product mentioned. However, all product names mentioned in this document are either trademarks of the companies referred to, registered trademarks of the companies referred to, or neither. Always be sure to investigate a particular product's name thoroughly before you use that name as your own.

1. Welcome to Cinepak for SEGA-CD

Cinepak makes it much easier to add full-screen, full-motion, Macintosh QuickTime movies to SEGA-CD. With Cinepak you can dramatically reduce your production time and improve the quality of video in your games. Specially tuned to enhance SEGA-CD playback, Cinepak technology uses high compression ratios and sophisticated color reduction techniques to fully integrate QuickTime movies with your programs.

This User's Guide provides basic information to help you at every step of Cinepak movie preparation. However, remember that there is an alternative to doing the QuickTime and Cinepak processing yourself. You can contract professional video production and file preparation services with a company who has QuickTime and multimedia experience. The information in this guide will help you, or contractors you hire, prepare high quality Cinepak movies.

Cinepak features

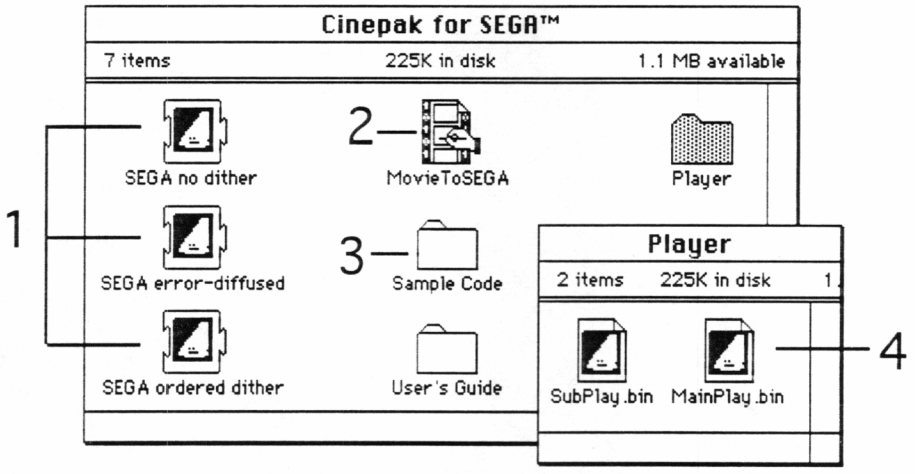
Frame rates	Up to 30 fps maximum (non-interlaced) for less than full-screen size images
Compression ratio	2:1 for most QuickTime movies
Color reduction	Vector-quantized color reduction, with error-diffused dither, ordered dither, or no dither
Color palettes	A maximum of 4 palettes, with a total of 64 colors (per frame)
Audio processing	16 KHz, 8-bit, mono audio, only from movie soundtrack or on-board FM synthesizer (no Red Book audio)
CPU driver integration	Single entry point binary code
QuickTime compatibility	Works with the standard QuickTime file format
Video to CD processing	MovietoSEGA converter for interleaved CD
Sample code included	Common routines and macros

About Cinepak and QuickTime

Cinepak for SEGA works with the QuickTime digital video format developed by Apple Computer for use on Macintosh computers. Cinepak processes QuickTime files, so before you can use Cinepak, you need to have your video and audio data transferred into the QuickTime format.

You use Cinepak for SEGA at the end of the QuickTime movie editing process, before adding movies to a game. Cinepak is a "slow front-fast end" processor—the up front processing time creates the best color match and performance currently possible on SEGA-CD systems.

The Cinepak for SEGA disk includes three Macintosh system extension files (QuickTime codecs), a processing utility, MovieToSEGA (that transforms Cinepak-compressed files), two SEGA drop-in movie player modules (binary code), sample source code for you to experiment with or use, as is, and User's Guide files:



1. Drop the Sega codecs in your Extensions folder to add new compression options to QuickTime compatible applications.

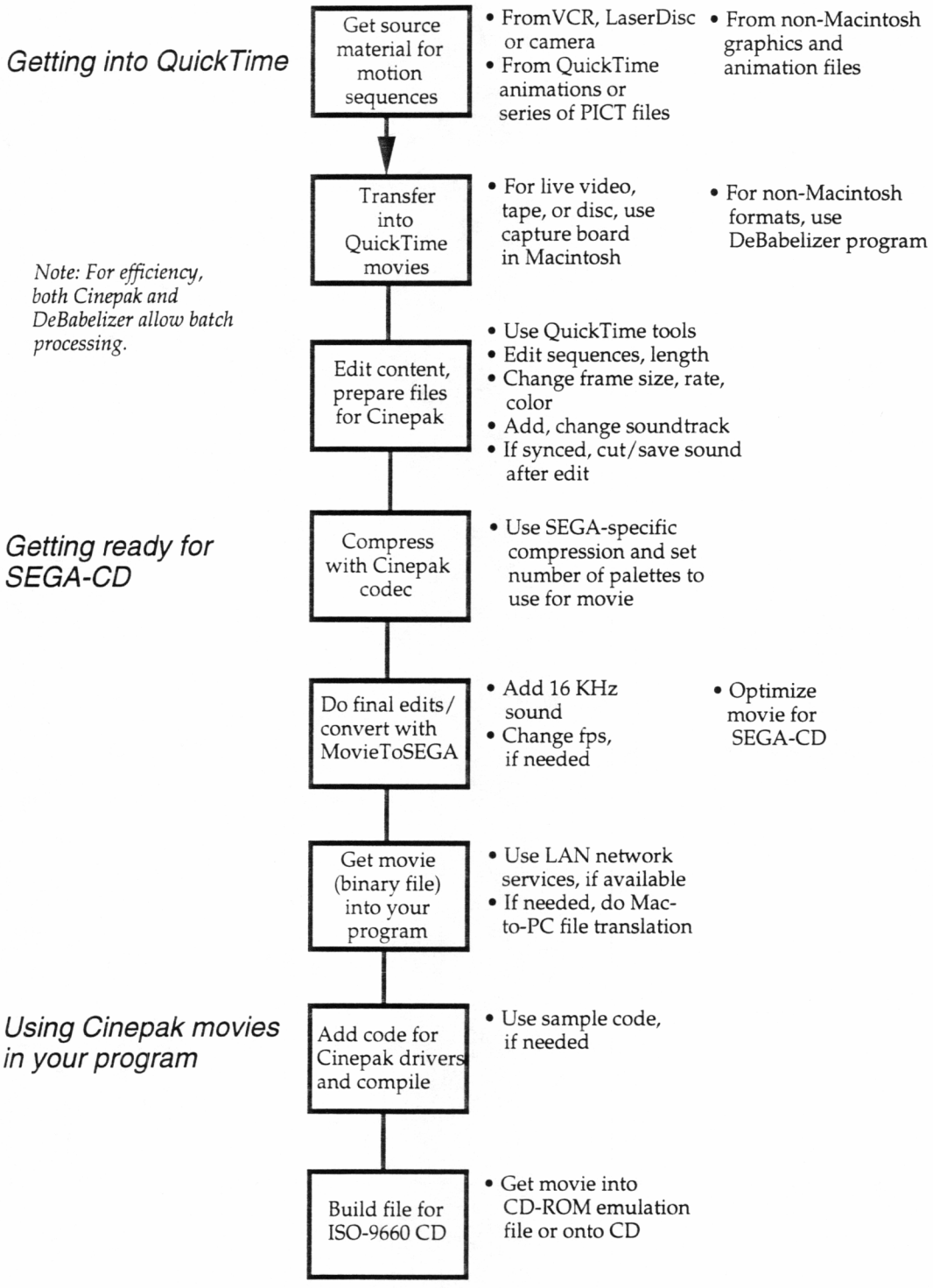
2. Use the MovieToSEGA utility to reformat compressed QuickTime files for SEGA-CD.

3. Review the sample code to see typical Cinepak Player routines.

4. Link the MainPlay.bin driver (single entry point binary code) to your MainCPU application. The SubPlay.bin controls video buffering, CD playback/sync, and frame decompression.

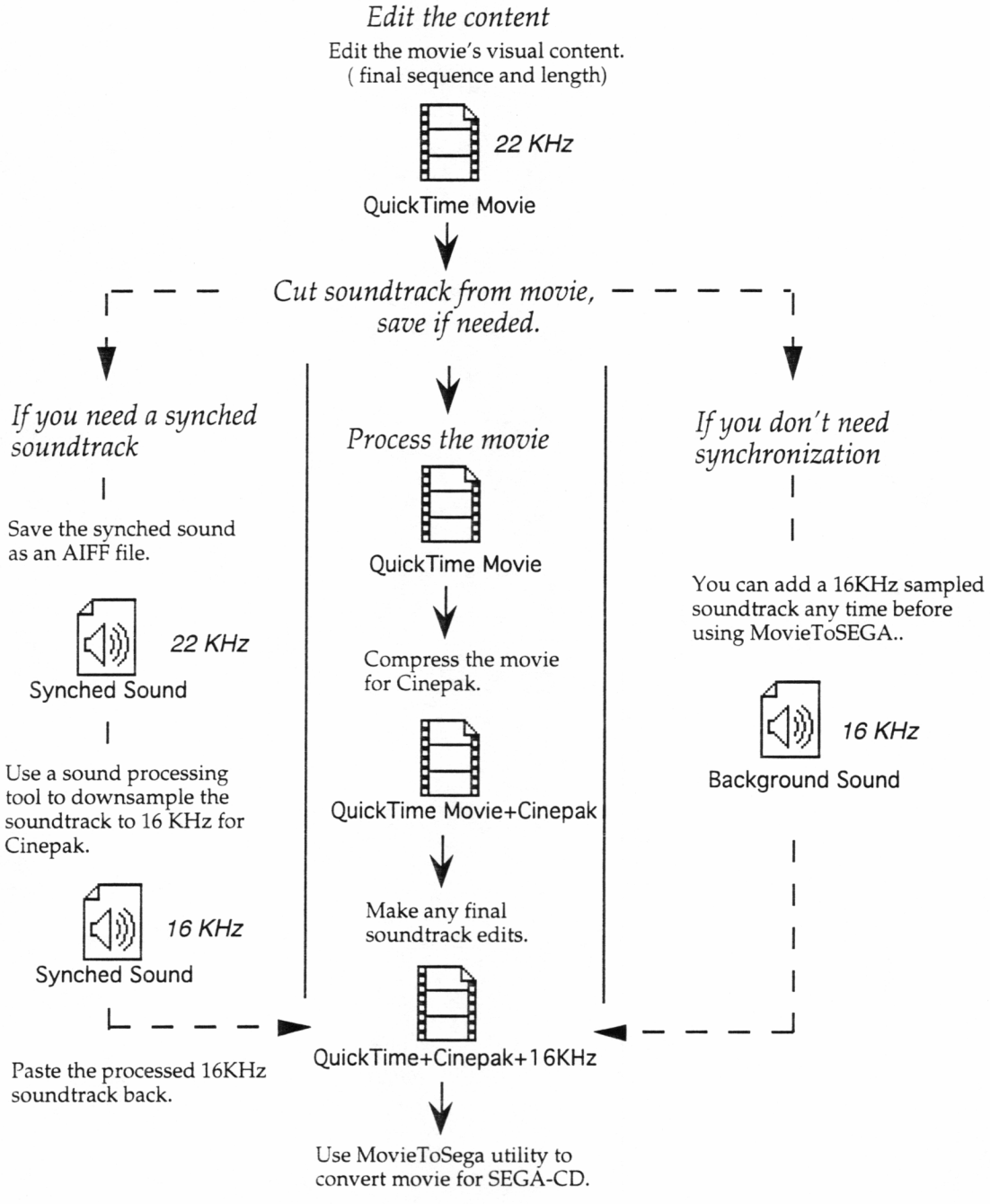
An overview of the video to SEGA-CD process

Below is a flowchart of the general process. Procedures will vary according to your specific needs.



About Cinepak audio and video synchronization

Cinepak for SEGA-CD requires 16 KHz audio. If your QuickTime movie's soundtrack is already at 16 KHz, you can work with it, just as it is, through the entire editing and file processing sequence. However, most QuickTime movie soundtracks are sampled at 22 KHz and need to be downsampled before you can use them in a Cinepak for SEGA-CD movie. The following illustration shows the typical process for cutting and downsampling a 22 KHz soundtrack, and pasting a 16 KHz soundtrack back into a movie.



Developer questions and answers

Here are frequently asked questions to help you understand more about how Cinepak works and what results you can expect.

Q. If I don't already use the QuickTime format on a Macintosh, what kind of system do I need to get started?

A. To create Cinepak movies, you'll need the QuickTime system extension installed on the hard disk drive of a Macintosh computer. Your Macintosh system needs at least 8 MB of RAM and system software version 7.0 or later. The higher the performance of your system, the less processing time required. Depending on your source material, you may need a video capture board and a CD-ROM disk drive. You'll also need appropriate QuickTime software tools. For a selected list of products and more details on the process, see Chapter 2, "Preparing Audio and Video for Cinepak."

Q. How do I get the best frame rates for Cinepak movies?

A. Smaller movie frames lead to faster rates. Full-screen movies can play at 12 fps; frames that are only 1/3 screen size can attain 25 fps. However, the ultimate factor determining the best rate for any Cinepak for SEGA movie is the specific data content for that movie. You'll need to experiment to find the best guidelines for different types of movies you want to use. For a formula to help you estimate frame rates, see Chapter 2, "General Steps in the Process."

Q. How does Cinepak achieve 64 colors per frame?

A. Cinepak uses a maximum of four palettes. However, a single character can have no more than 16 colors from one of the available palettes. Using Cinepak color reduction, your program can draw an entire image in one scroll plane.

Q. Can I play more than one Cinepak movie at a time in my program? Can I display other graphics or animation at the same time as the movie?

A. You can play just one movie at a time. While a movie is playing, you can show graphics and animation, but remember that the Main CPU still controls all action. You'll need to experiment to find acceptable playback speed. For best playback, limit on-screen graphics and design your frames with fast action inside the movie area only.

Q. Can I only use 16 KHz, 8-bit, mono sound in my movies? Can I have better sound in the other parts of my program? Can I have silent movies? When do I need to remove sounds that are not 16 KHz? Can I edit the movie after removing the non-16 KHz sound? When?

A. Cinepak handles 16 KHz sound, 8-bit mono, only. Anything else won't play. You can have a Cinepak movie with no soundtrack or an audio-only movie (no visual). Note that it's best to remove and downsample audio after you have the final length of the movie decided. (If you change the length and then add the sound back in, the sync will be off.)

Q, Can I use PCM sound while playing a Cinepak movie?

A. No. Cinepak takes over control of the PCM during playback.

Q. When should I use error-diffused vs. ordered dithering vs. no dithering at all when I compress movies with the Cinepak codec?

A. The best compressor to use depends on the kind of movie you want to compress. Experimentation and experience are your best guides, but here are a few tips:

- **SEGA-no dither:** Use this codec when the visuals in your movie are simple objects with few colors and details (no faces, for instance) and when the changes between objects, frame-to-frame, are minimal (creating little visual "noise").

- **SEGA-ordered dither:** This codec works best for movies in which the objects in scenes are more geometrical, less natural (as in landscapes), but there are very noticeable transitions between scenes.

- **SEGA-error-diffused:** Use this when you have complex frames and complex changes between frames—it gives the best smoothing of edges and blending of colors for more organic and natural ("noisy") imagery.

Q. Once I have the QT movie compressed for SEGA and converted to a Cinepak movie with synced soundtrack, how much more do I need to do to get it into my program?

A. You'll need to transfer the Cinepak movie file to DOS and add a few calls to your code to use the Cinepak Player drivers to control playback. See Chapter 3, "Playing Cinepak Movies On SEGA-CD," for details. You'll also need to compile and run the program before you can see the playback. Eventually, you need to build movies for an ISO-9660 CD-ROM track and move them into your CD emulation files or onto CD directly.

QuickTime and multimedia reference books

Following are a few current resources that you might find useful.

The Desktop Multimedia Bible, by Jeff Burger. Published by Addison-Wesley. 1993.

Digital Nonlinear Editing: New Approaches To Editing Film And Video, by Thomas A. Ohanian. Published by Focal Press. 1993

Inside Macintosh: QuickTime, by Apple Computer, Inc. Published by Addison-Wesley. 1993.

Inside Macintosh: QuickTime Components, by Apple Computer, Inc. Published by Addison-Wesley. 1993.

MacWorld Sound and Music Bible, by Christopher Yavelow. Published by IDG Books Worldwide, Inc. 1993

Mastering the World of QuickTime: Create Your Own Multimedia Videos on the Macintosh, by Jerry Borrell and the MacWorld editors. Published by Random House. 1993.

"The 1994 Multimedia Tool Guide," NewMedia Magazine. November 1993.

Premier with a Passion: Making Quality QuickTime Movies with Adobe Premier 2.0, by Michael Feerer. Published by Peach Pit Press. 1993.

QuickTime Handbook, by David Drucker and Michael Murie. Published by Hayden. 1992.

The QuickTime How To Book, by Sam Miller and Arno Harris. Published by Sybex. 1993.

QuickTime: Making Movies with your Macintosh, by Robert Hone. Published by Prima Publications. 1992.

Video Editing and Post-Production: A Professional Guide, 3rd Edition, by Gary H. Anderson. Published by Knowledge Industry Publications, Inc. 1993.

2. Preparing Audio and Video for Cinepak

The process of getting your original audio and video or graphic material into a SEGA-CD compatible format can vary depending on your original source material and the kind of results you want. Where you begin the process, how many steps you take, and the tools you need, all are based on what you have and what you want to do. This chapter provides information to help you decide what's best for you.

General steps in the process

Below you'll find a summary of typical procedures used by other developers to get good results with Cinepak. Following this summary are details on each step.

Install the Cinepak software
Get your video or graphics source into QuickTime
Do movie content, sequence, and sound editing
Save QuickTime audio as a separate file
If needed, change the frame rate or data rate
Compress the movie using a Cinepak for SEGA codec
Add SEGA-required 16 KHz audio
Save the movie as self-contained
Convert the file with the MovieToSega utility
Transfer the Cinepak movie to DOS
Add code to your program to control movie playback
Get the movie into a CD-ROM emulation file or onto CD
Compile and run

Install the Cinepak software

The files you need are on your Cinepak for SEGA disk. Drag the three SEGA codec files to your Extensions folder (in the System folder) and drag the MovieToSEGA utility to your hard disk.

Get your video or graphics source into QuickTime

Getting video footage into your SEGA-CD games requires that you have a QuickTime movie file of your source material. The following tips can help you transfer source material into QuickTime.

From a video source—An easy way to get video into a QuickTime file is to input the source (VCR, camera, or LaserDisc) through a video card in your Macintosh and into a QuickTime-compatible application. For best results when capturing video for QuickTime, use the S-Video format. Also, if you have a high quality audio recording board, record your original sound at 16 KHz and 8-bit, mono. This simplifies the audio portion of the transfer process later.

From non-Macintosh digital video—If you already have video captured in another digital format, there are ways to transfer that video into QuickTime. For instance, the DeBabelizer utility program can take digital video from a non-Macintosh format, such as Amiga, and translate it, frame-for-frame, into a QuickTime file.

From a Macintosh graphics source—If you have animation or still images in a Macintosh file format, you can use the Movie Converter utility to create a QuickTime file of your source material. Also, another QuickTime utility, Picture Compressor, can help in reducing the size of your original material.

From a non-Macintosh graphics source —DeBabelizer can process non-Macintosh files for the QuickTime format.

Do movie content, sequence, and sound editing

This is the best time to complete your movie's content, that is, the story editing, sequencing, and soundtrack for the final results you want in SEGA-CD. If you don't need a synched soundtrack, however, you can add the final audio later in the process.

Save your QuickTime audio as a separate file

Cinepak movies can play 16 KHz audio only, but you normally capture audio for QuickTime at 22.254 KHz and downsample it to 11.127 KHz when compressing a movie. The way to resolve this conflict is to use a QuickTime movie editing tool, such as Adobe Premier, to cut the original soundtrack, save it as an AIFF file, downsample the AIFF file using a sound utility. Then, after you compress the movie with Cinepak, paste the 16 KHz soundtrack back into the movie.

If needed, change the frame rate or data rate

QuickTime files typically have a 30 frames per second playback rate. However, depending on the size of your image, slower rates may give smoother playback on SEGA-CD. In general, SEGA full-screen images play back best at 12 fps in 32 column mode, not in 40 column mode. (Full frame in this case means 32 x 26 characters or 256 x 208 pixels.) Smaller images may look smoother at 25 fps. Some experimentation for your specific program is necessary. You'll need to use a QuickTime movie editing program, such as MovieShop, to reduce the movie's frame rate.

Important The maximum data rate for a Cinepak movie is 150 K per second. Here is a formula for estimating the maximum data rate for a specific movie:

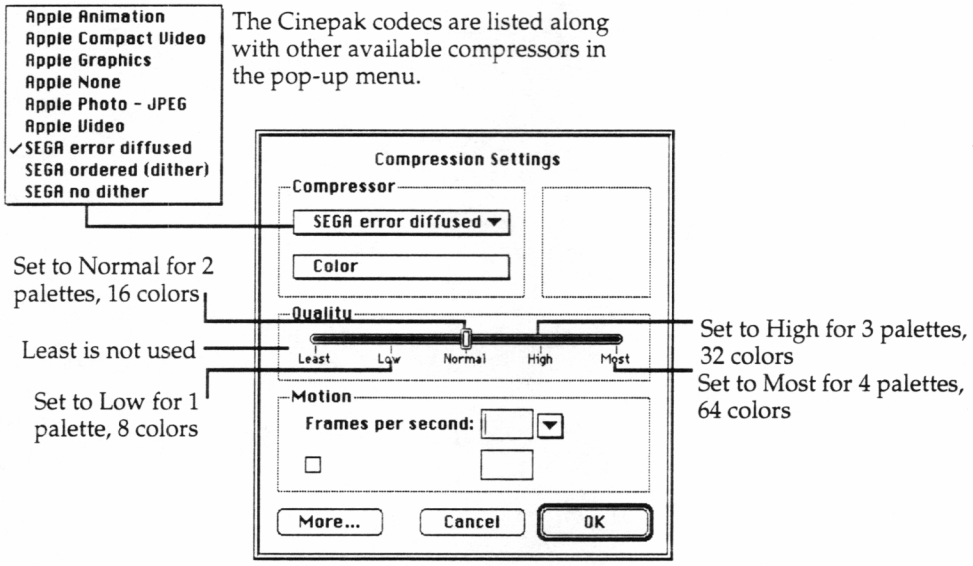
Frames per second x (# vertical chars x # horizontal chars x 32 bytes) ≤150 K per second

Compress the movie using a Cinepak for SEGA compressor

Use a compression utility, such as Movie Converter, from Apple, to compress your movie with one of the three SEGA options listed in the compressor pop-up menu. The Cinepak compressors also process a movie's color for SEGA-CD, according to the number of palettes you indicate.

Important Movie Converter does not work properly with movies longer than 54 seconds—instead, use the Convert to Movie utility, v1.5 or later, found on the Apple QuickTime Developer's Kit CD-ROM.

Before compressing a movie for SEGA-CD, set the number of color palettes with the quality slider bar. The following example shows Movie Converter's Compression Settings dialog box.



If you leave the slider on Normal, your movie will have 2 palettes: 0 and 1. For 4 palettes, drag the slider to Most. (Cinepak assigns palettes starting with palette 0.)

Add SEGA-required 16 KHz audio

Use the audio editing tool in programs such as MacroMedia's SoundEdit Pro to downsample the movie from its original rate to 16 KHz. Save the soundtrack as an AIFF file, then open that file in Movie Player (it becomes a movie with no visual content). Later you can copy the 16 KHz audio and add it to your new Cinepak-processed movie. (When pasting a soundtrack in Movie Player, remember to hold down the Option key.)

Save the movie as self-contained

In Movie Player, you must save the final QuickTime/Cinepak file as one self-contained movie file. All audio and video data should be in sync, but you may need to troubleshoot and tweak the movie to be sure that playback is exactly what you expect.

Convert the file with the MovieToSega utility

The final step in Cinepak processing is to use the MovieToSEGA application to transform your edited, Cinepak-compressed file into a SEGA-CD compatible movie.

Transfer the Cinepak movie to DOS

Use a program such as Mac-PC Exchange or Access PC to translate the movie into a DOS file that you can use in your program.

Add code to control movie playback

You'll need to add some code to your program to control the movie with the Cinepak Player drivers. For more details, see Chapter 3, "Playing Cinepak Movies on SEGA-CD." You can also experiment with the sample code included on your *Cinepak for SEGA-CD* disk.

Compile and run

Check that the playback is what you expect and that all your settings are restored as needed.

More about QuickTime tools

If you are new to making QuickTime movies, the following partial list of products can help you get started with the video capturing and editing techniques mentioned in this document. However, there are many other products available. This listing is offered as a quick reference for new developers and does not serve as an official endorsement by SEGA.

Some NuBus media capture cards/systems

SuperMac's *VideoSpigot* card and *ScreenPlay* software
RasterOps's *364*, *24STV*, or *MediaTime* digitizing boards and *MediaGrabber* software
NuVista+ *Videodigitizer* from TrueVision, Inc.
DVA-4000 digital video adapter and *MIC System 2* software from VideoLogic, Inc.
Digital F/X's *Video FX* (a complete production system)
DigiDesign's *AudioMedia* card can record 16-bit (CD quality) audio but Cinepak uses only 8-bit, mono, at 16KHz
Farallon's *MacRecorder Sound Digitizer* card and *SoundEdit* software
Studio 16 v 2.0, from Sunrize Industries, for Amiga, provides excellent sound editing, downsampling, and conversion and can output AIFF files usable by QuickTime (after some file type name modification using the ResEdit program).

Movie and sound editing software

Apple Quicktime Starter Kit v 1.6 includes:

MoviePlayer—Plays Quicktime movies and allows simple edits.

Movie Converter—Converts existing file formats into QuickTime. Supports PICS, AIFF, QuickTime movie, ScrapBook, PICT, TIFF 5.0, PC Paintbrush, CompuServe GIF, Targa, Windows 3.0, bitmap, and other file formats. Does compression, color depth, resizing and dithering. Allows you to turn a sequence of PICT files into a movie.

Picture Compressor—Compresses still images using a variety of standard ratios. Creates PICT files for use in existing programs. Does high quality JPEG compression from 10-20:1.

QuickTime ScrapBook—Enhanced version of a Macintosh desktop utility.

QuickClips CD-ROM—Contains sample animation, movies, and stills.

The Apple QuickTime Developer's Kit v. 1.6 includes a CD-ROM disc with:

The Apple Compact Video compressor

Photo CD support

GrabGuy video capture tool

MovieShop, an improved movie compression utility designed to work with the Compact Video compressor

Convert to Movie, v. 1.5 utiltiy

Reinstaller II utility

MPW, C, Pascal, and Assembly headers and sample code

For more information about the Apple Developer and Programmer's Association (APDA), call 800-282-2732.

Adobe System Inc.'s *Adobe Premier*—A high quality tool for combining video, audio, animation, still images, and graphics into a finished QuickTime movie.

File transfer and translation software

DeBabelizer from Equilibrium, lets you translate files from other computer platforms into QuickTime (and many other formats).

MacLinkPlus/PC, from DataViz, provides software and a cable to help you get Macintosh files over to a PC, and back.

Macintosh PC Exchange, from Apple, is a software-only solution for moving files between platforms when using the same kind of floppy disks or network services.

3. Playing Cinepak Movies on SEGA-CD

The information in this chapter can help you avoid common problems when integrating Cinepak movies in your applications. The sample code shows all basic calls, routines, and macros, plus the overall flow of events between the Main CPU and the Sub CPU.

How to get the best results

You don't need to add much code to your application to play Cinepak for SEGA-CD movies. However, to have the best quality playback, there are a few things to consider before you begin writing that code.

Prepare movies for SEGA-CD

Most problems with Cinepak movie playback on SEGA-CD result from not following the necessary steps in preparing a usable Cinepak movie file. The guidelines for preparing Cinepak movies found in the previous chapters of this guide can help you avoid common problems during playback.

Remember to save a copy of the QuickTime movie file at each stage of preparation for SEGA-CD. After experimentation, however, you may no longer need to save copies regularly.

Important: For playback on SEGA-CD, you must use a Cinepak codec with your movie file. However, there is no advantage to using other compressors before using Cinepak. If you use other compressors, you won't get significant reduction in file size, but you will most likely have poorer image quality in your final SEGA-CD movie.

For a rough preview of the results you can expect to see in your SEGA-CD playback, look at your QuickTime movie just after you use a Cinepak codec—you'll be previewing the final image quality on SEGA-CD. (For comparison, play a Cinepak-compressed version next to a QuickTime-only version.)

Set the scroll map size to 64 columns x 32 rows

Your application needs to initialize the Video Display Processor before playing Cinepak movies. Be sure to set the scroll map size to 64 columns x 32 rows. Display screen size for NTSC video is fixed at either 40 x 28 or 32 x 28 characters. For PAL, the display screen can be the same as NTSC or one other option: 40 x 30 and 32 x 30.

Restore settings after playing a movie

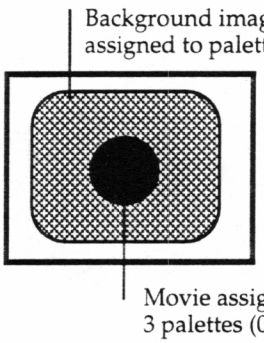
Before playing a movie, save settings that might be changed when the movie plays. Restore all changed settings immediately upon closing the movie file.

Following are typical settings you may need to reset after playback:

- scroll map size
- VRAM—Cinepak always buffers two full movie frames
- color palettes
- important registers
- memory mode

Assign palettes to avoid color distortion

Cinepak can handle a maximum of 4 palettes of 16 colors each and each frame can have a unique palette. By assigning palettes appropriately, you can eliminate potential color distortion caused by shared palettes.



Cinepak assigns palettes beginning at palette 0. In this example, the background image keeps its color integrity because it doesn't share palettes with the movie on screen.

About the Cinepak Player

The Cinepak Player, a high-level driver for Cinepak "films," provides basic playback from CD. It uses the Film format, described later in this section.

The Player comes as two bin modules that load into the Main and Sub CPU's. The MainPlay.bin module handles the main side of the playback process, managing the double-buffered display of Film frames. The SubPlay.bin module handles everything else: I/O and buffering of the CD-ROM, sound playback, and synchronization.

Following are the major activities of each Player bin module.

What the MainPlay.bin does

- Provides a single entry point, with one parameter
- Waits for the SubCPU to play a Film
- Cooperates with SubPlay.bin while the Film is playing
- Exits as soon as a Film has played

What the SubPlay.bin does

- Creates a temporary heap in program RAM to buffer frames loaded from CD-ROM
- Controls most of Film playback
- Controls the PCM chip and synchronizes sound
- Sets word RAM to 1M mode
- Finds appropriate frames to decompress
- Sends decompressed frames to the MainCPU

Communications between the SubCPU and MainCPU

If you plan to have your application communicate between the SubCPU and MainCPU, for example, process joystick input, you should **avoid using** the following registers.

The MainPlay.bin needs communication command registers $A12010 and $A2012 and the communication status register $A12020.

The SubPlay.bin needs communication command registers $FF8010 and $FF8012 and the communication status register $FF8020.

Player Routines

The MainPlay.bin module has only one routine. It keeps control of the MainCPU until the SubCPU calls another routine. The sample code provided later in this chapter shows an example.

The MainPlay.bin has just one parameter, `long Vbl`. This points to a user-defined routine called by the MainPlayer during vertical interrupt.

The SubPlay.bin module has three routines. Following is a description of each of these routines.

Set up playback with FilmOpen

`FilmOpen` has eight parameters that determine how to play the Film:

- `long filmSector` provides the logical sector number of the Film file.
- `long heapStart` and `long heapSize` parameters describe the location and amount of memory used for buffering CD input and output. For smooth playback, set `heapSize` to at least 80K. This memory is located on the CD side. The larger the frame size, the larger the buffer you need. Set it to at least the data rate (max. of 150K) and multiply by 2.
- `long yOffset` and `long xOffset` parameters describe the position of the film relative to the start of `mapRam` (in 64 columns by 32 rows).
- `long mapRam` parameter indicates which scroll window to use for movie playback.
- `long patternRam` specifies where to place decompressed image data in VRAM. There should be enough space for two full frames of video. For example, a 320 by 128 film has 640 8x8 cells. Each cell requires 32 bytes, so the pattern ram space required is 32*640*2 or 40960 bytes.
- `long priority` set to a non-zero value sets the priority bit in the pattern map.
- `long Vbl` is a pointer to a user-defined routine that the Player calls during vertical interrupt.

Note: When `FilmOpen` returns zero, the Film opened correctly. When `FilmOpen` returns -1, the film could not open. (By the way, in assembly code, the return value appears in the D0 register.)

Play the movie with FilmTask

It's important to call `FilmTask` periodically while a Film is playing. Other processing can proceed while the Film is playing, provided that `FilmTask` is called at least at every frame. It's best to just let the movie playback—the more time spent doing other processing, the less time available for the Film and the slower the playback speed.

`long FilmTask(void)` returns the current index in the Film sample table. When the movie stops playing, FilmTask returns -1 (or -2 if an error occurs).

Stop the movie with FilmClose

FilmClose stops the currently playing film, releases the PCM and CD, and frees up the MainCPU.

`long FilmClose(void)` returns zero when the movie stops playing.

Looking at the sample code

The following sample code, included with Cinepak for SEGA, shows a typical use of the Cinepak Player.

On the Main CPU side

To start, the Main CPU is set to perform a loop, waiting for the service call from the SubCPU side to play a movie. Note the VBL routine follows the play movie service routine.

```
;-------------------------------------------------------------------------
;  Main CPU side
;-------------------------------------------------------------------------
     org MAINOS_ADDR                          ;start of MAIN OS is $ff1000

MainOS:
     bsr   Initialize                         ;initialize the environment and hardware
```

```
;-------------------------------------------------------------------------;
;  Service loop                                                           ;
;-------------------------------------------------------------------------;
service_loop

        REQ_1M_SWAP                             ;tell sub you are ready for next service call
                                                ;wait for call
                                                ;invoke requested service
        move.l      #MAIN_1M_BASE,a0    ;1st entry is the service number
        move.l      #0,d0               ;make sure high order byte of d0 is 0
        move.w      (a0),d0             ;get number of service requested
        add.l       d0,d0               ;multiply by 2
        add.l       d0,d0               ;multiply again by 2 (now, service*4)
        lea         ServiceTable,a0     ;get address of service table
        move.l      (a0,d0.l),a0        ;get address of service routine
        jsr         (a0)
        bra         service_loop

doagain                                 ;should never get here
   bra.s doagain

;-------------------------------------------------------------------------
;  Play Movie - service 1
;-------------------------------------------------------------------------
MainPlayMovie
        movea.l     #MAIN_GA_BASE,a5        ;point a5 to gate array

wait13                                      ;look for 13 in comm register, sub side
        cmp.w       #13,GA_SUB2MAIN_COM6(a5)
        bne.s   wait13                      ;wait for command 13
        move.w      #13,GA_MAIN2SUB_COM6(a5); acknowledge to sub side

        move.l      #VBLSlave,-(a7)         ;ptr to VBL routine

        jsr     Cinepak_MainPlayer          ;call Cinepak main driver

        add.l   #4,a7                       ;restore stack ptr

        clr.w   GA_MAIN2SUB_COM6(a5)        ;clear comm register

        jsr     SyncWithSub                 ;call main sync routine

        GRANT_2M                            ;grant 2M memory back to subcpu

        rts

Cinepak_MainPlayer
        incbin  mainplay.bin
```

```
;-------------------------------------------------------------------------;
;     VBLSlave Routine                                                    ;
;-------------------------------------------------------------------------;
VBLSlave

     PUSHM   <d0-d7/a0-a6>                    ;save the register values

     bsr     ScanJoy                          ;scan joystick
     bsr     UpdatePointer

     POPM    <d0-d7/a0-a6>

     rts
```

On the Sub CPU side

After declaring constants, the SubCPU sets up a loop and calls a Cinepak movie, in this case "movie.seg." It then performs the necessary Cinepak routines.

```
;-------------------------------------------------------------------------
; Cinepak equates
;-------------------------------------------------------------------------
ScrollWindow            equ     $E000   ;pattern ram location
VDP_MovieStartAddr      equ     $20     ;VRAM location - decompressed image
xVid_XPos               equ     0       ;x offset in map ram
xVid_YPos               equ     0       ;y offset
MovieBufferSize         equ     $25800  ;size of buffer (150kb)
xVidBufferStart         equ     $10006  ;location of buffer
xVid_Pri                equ     1       ;priority
Movie                   equ     61      ;movie start sector on disk
FilmOpen                equ     0
FilmTask                equ     1
FilmClose               equ     2
;-------------------------------------------------------------------------
; Sub CPU Side
;-------------------------------------------------------------------------
   org $08000

ShellMain:

   bsr     Initialize                    ;syncs with main side,
                                         ;changes memory mode to 1M
```

```
;-------------------------------------------------------------------;
;     Setup and call Cinepak                                        ;
;-------------------------------------------------------------------;

ShellMovieLoop                          ;play movie - "movie.seg"
     move.w      #1,SUB_1M_BASE         ;request service 1 - play movie
     WAIT_FOR_1M_SWAPREQ                ;on main side
     SWAP_1M

     SOS_OPEN_MOVIE  #Movie,#VDP_MovieStartAddr,#ScrollWindow,
                     #xVid_XPos, #xVid_YPos,#MovieBufferSize,
                     #xVidBufferStart,#xVid_Pri,#VBLSlave
MovieLoop
     SOS_DO_MOVIE
     bge.s   MovieLoop

     SOS_CLOSE_MOVIE

Wait
                                        ;game over
   bra.s   Wait


;-------------------------------------------------------------------;
; Cinepak routines                                                  ;
;-------------------------------------------------------------------;
;-------------------------------------------------------------------;
; Init the movie                                                    ;
;-------------------------------------------------------------------;
InitMovie

     ; calls mPlayMovie on the Main-CPU side
     PUSH        a5
     movea.l     #SUB_GA_BASE,a5         ;a5 -> sub-cpu gate array
     move.w      #InitMovie,GA_SUB2MAIN(a5) ;set call

     move.w      #13,GA_SUB2MAIN_COM6(a5);send 13 to main side
                                         ; using comm register
waitmain
     cmp.w       #13,GA_MAIN2SUB_COM6(a5);wait until main acks
     bne.s   waitmain

     clr.w   GA_SUB2MAIN(a5)             ;clear call

     SET_1M_MODE                         ;set to 1M memory mode

     eor.w   #1,2(a5)                    ;swap meg up to main
     clr.w   GA_SUB2MAIN_COM6(a5)        ;clear movie sync command

     POP     a5

     rts
```

```
;-------------------------------------------------------------------------;
; Init the Cinepak subplayer                                              ;
;-------------------------------------------------------------------------;
Init_Cinepak_SubPlayer
        jsr             InitMovie               ;call the main driver

        move.l          a1,-(sp)                ;VBL Routine
        move.l          d0,-(sp)                ;priority
        move.l          d1,-(sp)                ;pattern address
        move.l          d2,-(sp)                ;scroll map base
        move.l          d3,-(sp)                ;xoff
        move.l          d4,-(sp)                ;yoff
        move.l          d5,-(sp)                ;buffer size
        move.l          a2,-(sp)                ;buffer start
        move.l          d6,-(sp)                ;cd sector of film
        move.w          #FILM_OPEN,-(sp)        ;start command

        bsr             Cinepak_SubPlayer

        add.l           #9*4+2,a7               ;restore stack

        rts
;-------------------------------------------------------------------------;
; Cinepak subplayer                                                       ;
;-------------------------------------------------------------------------;
Cinepak_SubPlayer
        incbin  subplay.bin                     ;Cinepak sub-cpu movie driver

;-------------------------------------------------------------------------;
; Close the cinepak subplayer                                             ;
;-------------------------------------------------------------------------;
Close_Cinepak_SubPlayer

        move.w          #FILM_CLOSE,-(sp)
        bsr             Cinepak_SubPlayer
        addq            #2,sp

        SET_2M_MODE

        jsr             SyncWithMain

        REQUEST_2M                              ;request 2M back
        SET_1M_MODE

        rts
;-------------------------------------------------------------------------;
;       VBLSlave Routine                                                  ;
;-------------------------------------------------------------------------;
VBLSlave
        PUSHM   <d0-d7/a0-a6>           ;save the register values

        POPM    <d0-d7/a0-a6>

        rts
```

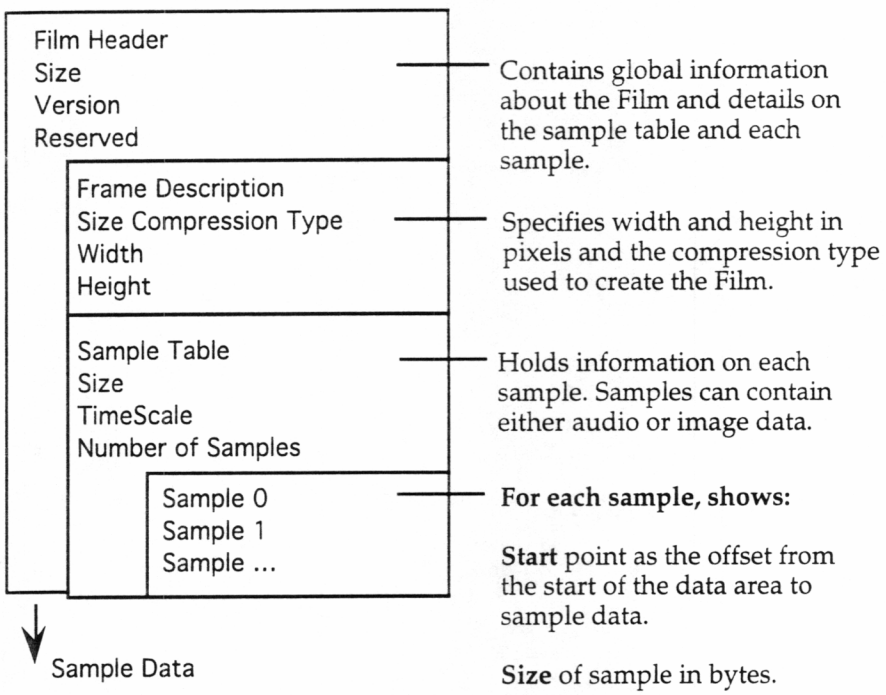
Cinepak macros for the SubCPU

Three macros are all that's needed to complete this example of typical Cinepak movie playback: Open Movie, Do Movie, and Close Movie. Following is the sample code for each macro.

```
;-------------------------------------------------------------------;
; Macros for Cinepak                                                ;
;-------------------------------------------------------------------;
;-------------------------------------------------------------------;
;     SOS_OPEN_MOVIE                                                ;
;                                                                   ;
;     Uses:  a6 - preserve old stack pointer                        ;
;-------------------------------------------------------------------;
SOS_OPEN_MOVIE macro cdRecAddr,patnaddr,scrollBase,xoff,yoff,BufSize,
                     BufStart,priority,VBLRoutine

     move.l      sp,a6          ;save current stack pointer
     move.l      #$7FFF0,sp     ;need some stack space

     PUSHM       <d0-d7/a1-a2>

     move.l      \VBLRoutine,a1
     move.l      \priority,d0
     move.l      \patnaddr,d1
     move.l      \scrollBase,d2
     move.l      \xoff,d3
     move.l      \yoff,d4
     move.l      \BufSize,d5
     move.l      \BufStart,a2
     move.l      \cdRecAddr,d6

     bsr         Init_Cinepak_SubPlayer

     POPM        <d0-d7/a1-a2>
     endm
;-------------------------------------------------------------------;
;     SOS_DO_MOVIE                                                  ;
;-------------------------------------------------------------------;
SOS_DO_MOVIE macro

     move.w      #FILM_TASK,-(sp)

     bsr         Cinepak_SubPlayer
     addq        #2,sp
     endm
;-------------------------------------------------------------------;
;     SOS_CLOSE_MOVIE                                               ;
;-------------------------------------------------------------------;
SOS_CLOSE_MOVIE macro

     bsr         Close_Cinepak_SubPlayer
     move.l      a6,sp          ;restore old stack pointer
     endm
```

Cinepak Film Format Specifications

A Cinepak Film file contains interleaved audio and video data of any shape, size, or frame rate. Film files usually start out as edited QuickTime movies and are converted for SEGA-CD with the Movie to Sega utility.



To optimize playback from CD-ROM, the MovieToSEGA utility interleaves sample data, which is stored immediately after the Film Header.

Cinepak measures time and duration by the sample table and defines TimeScale as a division of a second. For example, a TimeScale of 600 has a granularity of 1/600 of a second. A Time value of 300 tells plays the frame half a second after the start of the film. A duration of 20 indicates 1/30 of a second.

A sample duration of -1 indicates an audio sample. Although audio is currently limited to 16k, 8 bit mono, it is likely to become more flexible in the future.

Troubleshooting Cinepak for SEGA-CD movies

Following are a few problems you might encounter when first experimenting with SEGA-CD movie playback. You'll also find some suggested strategies for correcting these problems.

Video playback problems

The movie does not playback.

When you get no playback at all, check that you followed all the steps for preparing the movie. These steps are detailed in Chapter II of the User's Guide. If you see that you missed a step, use a version of the movie saved before the step you missed and repeat the process with the saved version.

Characters appear during playback.

If characters appear during playback, pattern RAM may be overlapping map RAM. To fix this, increase the size of pattern RAM.

The movie appears stuck and then loops back to the beginning before finishing playback.

There is a known problem that occurs when you use Apple's Movie Converter utility and a Cinepak compressor on a movie that is over 54 seconds long. The best way to convert long movies is to use the ConvertToMovie, v. 1.5, utility from Apple (on the QuickTime Developer's Kit CD-ROM). Note that before you can use this utility successfully, you need to drag your Cinepak compressor files (in the Extensions folder) to the ReInstaller II program icon. ReInstaller II is also found on the QuickTime Developer's Kit CD-ROM. Although this process gives you no feedback, it modifies your compressors so that they work successfully with Convert to Movie, 1.5.

Audio playback problems

The soundtrack skips rapidly.

The data rate may be larger than the heapsize can handle. Try increasing the heapsize by 50 or 100K, then play the movie again. To estimate the preferred data rate for a specific movie, see the formula provided in Chapter 2, "General Steps in the Process."

You hear a "popping" noise at the end of a movie.

Check that the length of the soundtrack matches the visual content exactly. Go back to the version of the movie you saved just before the MovieToSEGA conversion. If the soundtrack and visuals for that version don't match, change one or the other to match, do the conversion again, and use the new version in your application.